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Builder's Guide to Hot-Humid Climates

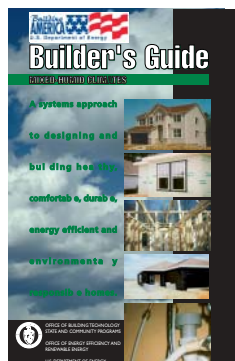
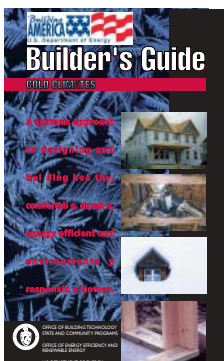
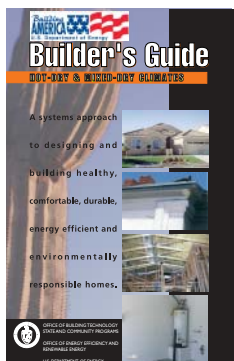
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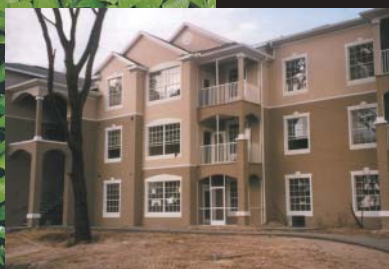




Builder's Guide

HOT-HUMID CLIMATES

A systems approach
to designing and
building healthy,
comfortable, durable,
energy efficient and
environmentally
responsible homes.



OFFICE OF BUILDING TECHNOLOGY
STATE AND COMMUNITY PROGRAMS

OFFICE OF ENERGY EFFICIENCY AND
RENEWABLE ENERGY

U.S. DEPARTMENT OF ENERGY

Builder's Guide

Hot-Humid Climates

A building science systems approach to designing and building homes that are healthy, comfortable, durable, energy efficient and environmentally responsible.

Funding for the production of this Builder's Guide was provided by the U.S. Department of Energy, Building Science Corporation and by the members of the Energy Efficient Building Association

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This guide was significantly enhanced by the thoughtful review of the following individuals whose input is greatly appreciated:

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Steve Baczek, Building Science Corporation
Mike Barcik, Southface Energy Institute
Terry Brennan, Camroden Associates
Dennis Creech, Southface Energy Institute
Don Gatley, Gatley & Associates
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Dan Langefels, Pulte Home Corporation
Stephanie Menegus, Building Science Corporation
Neil Moyer, Florida Solar Energy Center
Brad Oberg, IBACOS
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Rick Rigsby, Pulte Home Corporation
Armin Rudd, Building Science Corporation
John Tooley, Advanced Energy Corporation
Kohta Ueno, Building Science Corporation
Christian Yost, Yost Construction Consulting
Nathan Yost, American Lung Association
Ashton Young, Pulte Home Corporation

Book Design by: Sanders/Tikkanen Design & Illustration
Bruce Sanders, Ellen Tikkanen, Matthew Harless
Westford, MA (978) 692-9800

**Illustrations and
Production by:** Stephanie Menegus, Steve Baczek
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The information contained in this publication represents or is based upon the viewpoint and understanding of Joseph Lstiburek, Building Science Corporation and does not necessarily represent the viewpoint and understanding of any other person or entity.

Acknowledgments

The building science information presented in this guide and the companion guides for other climates has evolved over the past 100 years. Many individuals and numerous institutions, organizations and agencies have contributed significantly, often anonymously, to the wealth of information and experience contained here. Fundamental research from the research establishments of four nations — Canada, Norway, Sweden and the United States — provides the foundation for the construction details and approaches presented. More significantly, the lessons learned from the construction of the Arkansas House, Saskatchewan Conservation House, Leger House, Canada's R-2000 program and the U.S. Building America program were applied, altered, improved, discarded, rediscovered and massaged by builders throughout North America in thousands of field tests and experiments, sometimes referred to as home-building. The experience from these lessons can be found in the following pages.

Joseph Lstiburek,
Westford, MA
July, 2000

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About this Guide

Buildings should be suited to their environment. It is irrational to expect to construct the same manner of building in Montreal, Memphis, Mojave and Miami. It's cold in Montreal, it's humid in Memphis, it's hot and dry in Mojave and it's hot and wet in Miami. And that's just the outside environment. It is equally irrational to expect to construct the same manner of building to enclose a warehouse, a house or a health club with a swimming pool. The interior environment also clearly matters.

We have accepted that design and construction must be responsive to varying seismic regions, wind loads and snow loads. We also consider soil conditions and frost depth, orientation and solar radiation. Yet we typically ignore the variances in temperature, humidity, rain of the exterior climate and the variances in the interior climate.

Building envelopes and mechanical systems should be designed for a specific hygro-thermal region, rain exposure zone and interior climate class in addition to the previously mentioned external environmental loads. The following hygro-thermal regions, rain exposure zones and interior climate classes influence design:

Hygro-Thermal Regions (see pages xiv and xv)

- Severe cold
- Cold
- Mixed-humid
- Hot-humid
- Hot-dry/Mixed-dry

Rain Exposure Zones (see page 66)

- Extreme (above 60 inches annual precipitation)
- High (40 to 60 inches annual precipitation)
- Moderate (20 to 40 inches annual precipitation)
- Low (less than 20 inches annual precipitation)

Interior Climate Classes

- I Warehouses, Garages, Storage Rooms
 - Temperature moderated
 - Vapor pressure uncontrolled
 - Air pressure uncontrolled

- II Houses, Apartments, Condominiums, Offices, Schools
 - Temperature controlled
 - Vapor pressure moderated
 - Air pressure moderated
- III Hospitals, Museums, Swimming Pool Enclosures and Computer Facilities
 - Temperature controlled
 - Vapor pressure controlled
 - Air pressure controlled

This builder's guide focuses on construction in a hot-humid hygro-thermal region with rain exposure zones varying from moderate to extreme for building envelopes and mechanical systems suited for a Class II interior climate — that is an interior climate that is temperature controlled, vapor pressure moderated and air pressure moderated. In other words houses, apartments, condominiums, townhouses, and manufactured housing.

Hygro-Thermal Region for this Guide

This guide contains information that is applicable to hot-humid climates. Hot-humid climates are defined as regions that receive more than 20 inches of annual precipitation and where the monthly average outdoor temperature remains above 45° F throughout the year.

Figure A, Climate Zones, illustrates the five major climate zones in North America used to distinguish the range of applicability of this guide and the companion guides for cold, mixed-humid and hot-dry/mixed-dry climates. Each climate zone specified is broad and general for simplicity. The climate zones are generally based on Herbertson's Thermal Regions, a modified Koppen classification (see Goode's World Atlas, 19th Edition, Rand McNally & Company, New York, NY, 1990), the ASHRAE definition of hot-humid climates (see ASHRAE Fundamentals, ASHRAE, Atlanta, GA, 1997) and average annual precipitation obtained from the U.S. Department of Agriculture. For a specific climate zone, designers and builders should consider weather records, local experience, and the micro-climate around a building. Elevation, incident solar radiation, nearby water and wetlands, vegetation, and undergrowth can all affect the micro-climate.

Although this guide provides general recommendations with applicability based on Figure A, local experience and local building codes should also be considered. Where a conflict between local code and regulatory requirements and the recommendations in this guide occur, authorities having jurisdiction should be consulted or the local code and regulatory requirements should govern.

The recommendations on construction relating to wind loading and seismic zones are extremely general and are not intended to substitute for professional design by a professional engineer or licensed architect and are not intended to conflict with specific code requirements. The recommendations are intended to alert the reader that conditions vary significantly across the hot-humid zone defined in Figure A and that due diligence should occur.

Illustrations depicting wood framing are shown with exterior walls framed using 2x6 framing techniques. The colored lines or colored shading on all illustrations represent materials that form the air flow retarder system.

Precise specification of materials and products is not typically provided on the illustrations or in the text to provide maximum flexibility. It is the responsibility of the designer, builder, supplier and manufacturer to determine specific material compatibility and appropriateness of use. For ex-

ample, there are a wide range of performance and cost issues dealing with sealants, adhesives, tapes and gaskets. Hot weather or cold weather construction and oily, damp or dusty surfaces affect performance along with substrate compatibility issues. Tapes must be matched to substrates. Similarly, sealants and adhesives must be matched to materials and joint geometry. In hot-humid climates, intense solar exposure typically results in damage to materials from ultraviolet radiation. Paints, sealants and coatings have greatly reduced service lives. Roofing materials and wood products are particularly sensitive.

Generally, several different tapes, sealants, adhesives or gaskets can be found to provide satisfactory performance when installed in the locations illustrated in this guide. Premium tapes, sealants, adhesives or gaskets typically (but not always) out perform budget tapes, sealants, adhesives or gaskets. It is always advisable to obtain samples and test compatibility and performance on actual material substrates prior to construction and over an extended period of time.




Figure A
Hygro-Thermal Regions


- Based on Herbertson's Thermal Regions, a modified Koppen Classification, the ASHRAE definition of hot-humid climates and average annual precipitation from the U.S. Department of Agriculture and Environment Canada

Legend


Severe-Cold

 A severe-cold climate is defined as a region with approximately 8,000 heating degree days or greater


Cold

 A cold climate is defined as a region with approximately 4,500 heating degree days or greater and less than approximately 8,000 heating degree days

Mixed-Humid

 A mixed-humid climate is defined as a region that receives more than 20 inches of annual precipitation, has approximately 4,500 heating degree days or less and where the monthly average outdoor temperature drops below 45°F during the winter months

Hot-Humid

 A hot-humid climate is defined as a region that receives more than 20 inches of annual precipitation and where the monthly average outdoor temperature remains above 45°F throughout the year*

Hot-Dry/Mixed-Dry

 A hot-dry climate is defined as a region that receives less than 20 inches of annual precipitation and where the monthly average outdoor temperature remains above 45°F throughout the year;

A mixed-dry climate is defined as a region that receives less than 20 inches of annual precipitation, has approximately 4,500 heating degree days or less and where the monthly average outdoor temperature drops below 45°F during the winter months

* This definition characterizes a region that is almost identical to the ASHRAE definition of hot-humid climates where one or both of the following occur:

- a 67°F or higher wet bulb temperature for 3,000 or more hours during the warmest six consecutive months of the year; or
- a 73°F or higher wet bulb temperature for 1,500 or more hours during the warmest six consecutive months of the year

Approach

Reducing a builder's number one headache: warranty and callback expenses, should be considered a "payback" concept. Reducing warranty and callback expenses often involves increasing initial construction costs. The good news to the builder is that the up front cost to the builder results in subsequent cost savings also to the builder. It is logical to pay a little more up front to prevent warranty and callback expenses, rather than a great deal more down the road to deal with warranty and callback expenses.

Building energy-efficient homes can also be considered a "payback" concept. Energy-efficient construction usually involves upgrading materials or equipment to increase the energy efficiency of a home. These changes typically add to the initial cost of a home. Economically, the increased cost is often justified to the home owner based on subsequent cost savings from reduced energy bills. This is also a "pay more up front" and get savings "in the long term" approach. Unfortunately, for the builder, the up front cost is to the builder, but the subsequent cost savings is to the home owner. Builders have to pass on the up front costs to the home owner resulting in a more expensive home. Not all home owners recognize the long term savings from this approach and typically object to the higher up front costs.

The payback concept is not the only approach to reducing warranty and callback expenses or the only approach to energy-efficient construction. There are "break points" where the cost of the warranty and callback reduction strategies as well as the energy-efficient features are balanced by the reductions of other construction costs. These "break points" involve construction strategies or levels of energy efficiency that allow a specific component of a building to be downsized or deleted. For example, construction costs can be increased by changes and improvements to the building envelope that reduce warranty and callback expenses as well as reduce heat gain and heat loss. The improved building envelope performance allows the mechanical equipment to be downsized. The initial construction cost increases are offset by the reduced costs associated with the downsized mechanical system.

The construction cost savings that occur from applying a systems engineering approach to warranty and callback reduction, and energy conservation, are typically able to pay for the increased costs associated with "healthy housing" and resource efficiency. The end result be-

comes a home that is healthier, safer, more comfortable, durable and affordable, with no increased cost to the builder or home buyer.

This builder's guide addresses both warranty and callback expenses as well as energy-efficient construction. Strategies are presented to reduce drywall cracking, nail pops, paint and trim problems, dust marking of carpets, comfort complaints and "ghost-marking" of studs and other framing.